# OIL AND GAS EXPLORATION

# IN CANADA'S ARCTIC ISLANDS

THE
ARCTIC INSTITUTE
OF
NORTH AMERICA

Robert Currie delivered this address on April 27, 1973 at the 13th annual Washington, D.C. meeting of members and friends of the Arctic Institute of North America.

Mr. Currie is a governor of the Arctic Institute and serves on several of its working committees. One of Canada's most respected oil executives, he presents a valued insight into his country's oil and gas industry.

His address is an excellent summary of what his company is doing to develop the resources of the Canadian Arctic Islands. We are pleased to widen his audience by making his address available as an Arctic Institute publication.

Patrick H. O'Neill
Chairman
Board of Governors

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By

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The Canadian Arctic Islands are located along the northern edge of Canada between 70 degrees and 83 degrees north latitude. They extend over 1,000 miles from Ellesmere Island in the east to Banks Island in the west. For centuries, the main incentive for exploration in the High Arctic was to seek out the fabled Northwest Passage for purposes of trade with the Orient. But only limited information was accumulated in that time because the arctic archipelago repelled the explorers who ventured into it.

The explorer-scientist Sir John Franklin, who died in the Arctic Islands with his entire company in 1845, was one of the first to contribute authoritative information on the region. The some forty expeditions sent out to find Franklin added the first real store of knowledge of this remote and inhospitable area.

The Northwest Passage was found, of course. Amundsen navigated east to west through the maze of ice and islands in 1903, and the Royal Canadian Mounted Police vessel St. Roch first made the passage both ways, completing a west-to-east voyage in 1942 and an east-to-west voyage in 1944. The northern trade route to the Orient is no longer an incentive for exploration in the Arctic, but another powerful inducement has taken its place: the exploration for oil, gas, and minerals.

The Canadian Government has for years been conducting systematic surveys and reconnaissance of the Arctic Islands. After World War II, the Royal Canadian Air Force completed aerial photographic coverage of the area from which accurate photographs and maps are available. The Geological Survey of Canada conducted geological reconnaissance as well as regional seismic and gravity surveys. The Canadian Coast Guard measured ice and water thicknesses, and recorded seasonal ice behavior. Land surveys were run into the area and triangulation stations established from which one's location in the area can be determined. Jointly with the United States, weather stations were established and manned at Eureka on Ellesmere Island, at Isachsen on Ellef Ringnes Island, at Mould Bay on Prince Patrick Island, and at Resolute on Cornwallis Island.

Not, however, until the early 1960's after the Government opened up the land for oil and gas exploration did extensive commercial exploration take place. Starting with the background information developed by the Canadian Government, geologists set out to explore the Arctic Islands, which although remote appeared geologically to be a major storehouse of fossil fuels. The first well was drilled in 1962 at Winter Harbour on Melville Island, a site named for the winter shelter offered to early explorers of this area.

## The Nature of the Islands

Contrary to common belief, the Arctic Islands are not perpetually ice bound and glacier covered. The central and western islands are of low relief and receive from 2-1/2 to 5 inches of annual precipitation, so they are a frozen desert. In the east, Ellesmere Island, Axel Heiberg Island, and parts of Devon Island are mountainous, with the higher elevations covered with permanent glaciers.

Less than 8 percent of the land is permanently ice covered. For one to three months in the summer, the rest of the land is bare of snow. Although farther

e eastern islands, apparently affected by the Greenland current, are
hus the sea ice breaks up earlier and the waters remain open longer
he west.

ratures range from an occasional 70°F during the summer to -60°F during
Temperatures do not drop as low as in central Canada and Alaska, but
ion of cold is longer. Typical weather conditions are:

| ocation | February mean temp. (°F) | Average wind (mph) | July mean temp. (°F) |
|---|---|---|---|
| °09'N 86°00'W | -35.2 | 6.6E | 42.2 |
| 78°47'N 103°32'W | -33.9 | 7.9N | 38.6 |
| 76°15'N 119°35'W | -31.7 | 8.6NW | 39.2 |
| 74°41'N 94°54'W | -28.6 | 11.5W | 40.3 |

life is tortured and sparse so that life forms on land are minimal.
n desert, with less precipitation than the Sahara, is incapable of sup-
ough plant or animal life to sustain even a meager population. Hence,
o Eskimo or other native habitation in the areas where Panarctic operates.

nd is underlain with permafrost ranging from a few hundred feet to
feet in higher inland areas. At the coast, the permafrost thins
nd, except in shallow water, is gone a short distance from shore.

ree months, from early November to early February, the area is in
ness and for three months, from early May to mid-August, the sun never
the horizon. With increasing temperatures and 24 hours of solar heat,
rozen soil begin to melt in early June. In other than sandy or
s, this thawing limits the movement of drilling rigs and heavy equip-
early September the land is again frozen.

east the ice breaks up sufficiently to permit ocean shipping with
support from July 15 to October 15. Ice conditions become progres-
e to the west, reducing the shipping season. Panarctic's Rea Point
erally accessible between August 25 and September 30.

tely for the oil explorers the land surface has not been overburdened
l residue and there is little noticeable vegetation cover. As a
rock geological formations lie mostly exposed, greatly simplifying
exploration and interpretation. From a geologic standpoint, the
nds sedimentary basin has all the necessary elements of large
thick reservoirs, abundant source beds, and available cap rock
o the generation and entrapment of hydrocarbons in prolific quantities.

adian Petroleum Association estimates the potential reserves of the
nds and the Arctic Coastal Plain at 43 billion barrels of oil and 260
bic feet of gas. The Arctic Islands account for about 35 billion
bil and 200 trillion cubic feet of natural gas. Other authorities
en higher potentials (up to 100 billion barrels of oil and 500 trillion
bf gas). Many of the geologic structures are huge, with thick reser-
le of containing 5 to 10 billion barrels of oil or 10 to 20 trillion
bf gas. Thus these potential estimates would seem to be attainable.
e inducement that caused the formation of Panarctic Oils Ltd. in 1967.

## Panarctic Oils Ltd.

By the mid-1960's, about all the land in the Arctic Islands had been taken under exploration permits, not by the major oil companies but by independents, individuals, and mining companies. These landholders individually had neither the financial resources nor the expertise to carry out effective oil and gas exploration, and so they were in danger of losing their rights if work obligations were not undertaken or if substantial permit fees were not paid to the federal government.

Panarctic Oils Ltd. was formed to assemble the Arctic Islands holdings of these numerous individual owners into a consortium with the capability to carry out effective exploration. These independents "farmed out" their Arctic Island holdings to Panarctic in exchange for a retained interest in their properties, which would then be partially explored. Arranging initial financing at that time was most difficult, but eventually a formula was reached whereby 19 companies, largely Canadian, purchased 55 percent of Panarctic's equity and the Canadian Government purchased the remaining 45 percent to raise first $20 million then an additional $10 million required to conduct the initial exploration efforts.

## Financing

Until recently, Panarctic's shareholders had committed a total of $76 million for the exploration program. During November 1972, Panarctic's participants agreed to an additional capitalization of $25 million. Inasmuch as all present participants have agreed to subscribe for their pro rata share of this additional financing, there is no change in their percentage interest holdings. This expansion brings the cumulative investment of the shareholders in the Panarctic venture to $101 million.

Of this amount, approximately $60 million has been spent since 1968 on exploration and drilling on Panarctic's landholdings. At this date, the Company has a net investment in capital facilities of some $5 million and a further investment of $7 million in inventories of fuel and drilling supplies in the High Arctic. This leaves a committed but unexpended $29 million which will carry Panarctic's share of the exploration program into 1974.

In addition, Panarctic consumated a significant financing arrangement during 1971 with four U.S. gas companies: Tenneco Inc., Columbia Gas System, Inc., Texas Eastern Transmission Corporation, and Northern Natural Gas Company. Basically, the arrangement is that the gas companies will expend from mid-1971 to mid-1976 a firm $50 million on exploration drilling and up to $25 million on delineation drilling to confirm the extent of gas reserves discovered. The gas companies have five annual options to extend the arrangement for additional commitments aggregating $15 million per annum. When a market outlet for gas is assured, the gas companies will provide the funds for whatever gas development drilling is required. To date, some $13.5 million has been spent under this arrangement, primarily on exploration drilling.

The agreement provides that the gas companies will have first rights to purchase gas developed under this agreement and approved for export from Canada at prices to be negotiated at the time. In addition, the gas companies will be entitled to recover their investment, plus an interest factor, from 25 percent of Panarctic's net wellhead gas revenue. By combining the contractual commitments of Panarctic's own shareholders with those of the four gas companies, Panarctic has a reasonable expectation of available funds of some $40 million per annum for the next several years. In addition, Panarctic has "farmed out" partial interests in a small percentage of its lands to get an additional $50 million to $75 million of exploration work done by others.

It is interesting to relate Panarctic's expenditure level of about $1.00 per acre on its landholdings of approximately 60 million acres to exploration work done in other areas of Canada. By way of comparison, the oil and gas industry has spent some $600 million on exploring 42 million acres in British Columbia and some $1.3 billion on 86 million acres in Alberta. Clearly, Arctic Islands exploration is only in its infancy, but the success ratio of drilling to date has been good and the finds large, so that unit costs of discovery per barrel or per million cubic feet are highly favorable in comparison to other areas.

## Land

Original farm-in agreements from a large number of companies provided Panarctic with the opportunity to earn varying interests in 45.1 million gross permit acres subject to certain specific obligations and options. By the end of 1967 the company had, by direct acquisition, added 2.5 million gross acres, so that with the commencement of field operations early in 1968 holdings amounted to 47.6 million acres. From that time to the present, further acquisitions, both direct and by farm-in and for different interests, amounted to 30 million gross acres, bringing total current holdings to 78 million gross permit acres.

## Exploration

In the Arctic Islands, Panarctic started with the knowledge assembled chiefly by the Geological Survey of Canada, other government agencies, and J.C. Sproule and Associates. First to be studied was regional geology, which provided a classification of prospective areas. The lack of overburden in the islands have helped surface geology reveal many large structures which elsewhere have contained oil and gas. Where sedimentary rocks are exposed, as at King Christian and Isachsen Dome, geologists determined their nature, thickness, and sequence.

Since sedimentary rocks are exposed at the surface throughout large areas of the Arctic Islands, surface mapping by photogrammetry is effective and is used extensively. Under the sea and where surface beds mask the configuration of deeper strata, geophysical tools must be used to determine whether there are structures which could be targets for drilling. Even where there is surface expression of a structure, this may be misleading as to the location of the subsurface structure itself and hence inadequate for purposes of selecting drilling locations.

The most accurate tool for selecting drilling locations is the seismograph, but it is also the most expensive. Panarctic therefore uses gravity meter surveying more than is usual in other parts of Canada. Where gravity surveys give indications of structures which appear to be worth examining in a more precise way, the next step is seismic work. In addition to defining subsurface structures, seismographic work is helpful in predicting the depths at which various formations will be encountered.

Panarctic and its seismic contractors have had to both experiment and adjust operating and interpretive techniques to make the most meaningful use of seismographic shooting. It has been necessary to learn how to apply proper allowances for the effect of varying depths of permafrost on seismographic readings. Also, it has been necessary to develop similar expertise where seismic work has extended from the land onto the sea ice which drastically complicates interpretation. In addition the presence or absence of permafrost under the seabed contributes distortions.

Seismic crews have learned how to contend with long periods of total darkness. This has made it possible to obtain more seismic information and to establish drilling locations at an increasing rate.

During the next 12 months, Panarctic will be embarking on its most ambitious exploration program to date. The Company has six rigs under contract. It has scheduled 23 holes for this period--18 of its own and 5 more by farmees. Other companies have seven drilling rigs in the area. In total, some 33 wells will be drilled in the Arctic Islands over the next year.

## Exploration Achievements

By 1971, out of 12 wildcat wells drilled by Panarctic, three resulted in major gas discoveries: at Drake Point on Melville Island, at King Christian Island, and at Kristoffer Bay on Ellef Ringnes Island. In 1972, continued drilling yielded discoveries at Thor Island near Ellef Ringnes Island, and at Hecla on Melville Island. Encouraging oil recoveries were also obtained at Romulus on Ellesmere Island. This in itself is a success ratio far exceeding the general average set by the industry, particularly for an unknown and relatively unexplored area.

The discoveries have been large and the completed gas wells have high deliverability. The King Christian N-06 well has an absolute open flow (AOF) of 410 million cubic feet per day (mcf per day) and has actually flowed at sustained rates up to 188 mcf per day. The Drake Point F-16 well has an AOF of 265 mcf per day and the Hecla F-62 well has an AOF of 100 mcf per day.

## Operations

With five years of arctic experience, Panarctic has normalized its operations, having identified and come to grips with the principal problems that distinguish arctic operations from oil and gas operations elsewhere in Canada. The climate is harsh, so living and working areas must be protected. While drilling rigs can often be moved overland or over ice to a nearby island, movement by air is essential between the islands and for long-distance moves on an island. The Lockheed Hercules freighter aircraft handles this job admirably. It also keeps drilling rigs and camps supplied with fuel and heavy equipment.

Since personnel, food stuffs, and daily maintenance supplies must be obtained far to the south, rapid and efficient north-south air transport is essential. Panarctic employs a Lockheed Electra L-188 freight configuration aircraft for this service. Since geological, geophysical, and drilling operations are spread over hundreds of miles throughout the islands, inter-island transport is also essential. Panarctic employs de Havilland Twin Otter aircraft for these purposes. Communication is another necessary ingredient, and here Panarctic employs single-sideband, high-frequency transceivers to communicate among its drilling rigs and bases, and directly from these locations to Edmonton and to its head office in Calgary.

Fuel and heavier materials required for drilling, including casing, drilling mud, and cement, are most economically transported into the Arctic by ship during the late summer navigation period. This sealift operation requires storage at arctic bases, and Panarctic maintains two such bases: one on Ellesmere Island and the main base at Rea Point on Melville Island. The Rea Point base provides accommodation for over 100 men and has a 5,000-foot all-season runway equipped with the best air navigational facilities in the Arctic. The base serves as the central point from which men, drilling materials, and fuel are dispensed to locations in the central and western islands. The base is also an important focal point for weather information.

Because of logistic problems and the limitations on times when drilling rigs and heavy equipment can be moved, long-range planning has become essential in reducing costs. The sealifting of fuel and drilling supplies to centralized areas of activity greatly reduce costly air transport. In 1972, Panarctic sealifted over 45,000 tons of supplies, including 7 million gallons of fuel.

Where wells are to be drilled on the same island, say within a distance of 100 miles, it is less costly to make the move overland by trucks if the terrain permits. Where overland moves are not possible, Hercules aircraft can move a rig in 70 to 90 trips over a period of 10 days. Although more costly, air movement has proved highly effective. During the past year Panarctic has taken over complete operation of its own aircraft from contractors and trained its own crews to peak efficiency which, besides allowing greater flexibility of aircraft, has reduced costs per ton mile well below previous contracts.

## The Way to Market

To date, Panarctic has discovered principally natural gas. In order for these gas reserves to be economically marketed, threshold reserves must first be assembled. It is believed that 25 to 30 trillion cubic feet of gas will be the amount required to support the economic feasibility of a pipeline out of the Arctic. This represents a 50-percent increase in Canada's present gas reserve.

The amount of oil reserves required depends upon the location. For instance, a smaller threshold oil reserve is required if reserves are established on Ellesmere Island in the eastern Arctic which is more readily accessible most of the year by tanker along the west coast of Greenland.

When threshold reserves of natural gas have been established sufficient to support a pipeline, the route would proceed from the Arctic Islands over the Canadian Shield where the absence of tundra-type soils and high water content permafrost minimizes construction and ecological problems. Such a pipeline will involve some 2,800 miles of at least 48-inch-diameter pipe and may cost several billion dollars.

A group composed of TransCanada PipeLines Ltd., Panarctic Oils Ltd., Canadian Pacific Investments Ltd., and Tenneco Oil & Minerals Ltd. has entered into an agreement for the conduct of appropriate research, investigations, and planning for this project. The undertaking is called the Arctic Islands Gas Pipeline Project and is coded the Polar Gas Project. TransCanada PipeLines will manage the project, and much expertise will be provided from the staffs of the participating companies. These four companies bring to the group considerable knowledge and experience in gas pipeline transmission, in transportation in general, and in arctic operations. The members of the group understand the nature of the problems involved and are not unfamiliar with the solution of similar problems encountered in the past.

The work scheduled for 1973 involves extensive environmental studies by consultants along with engineering work such as aerial photography, on-the-ground surveys, soil sampling, permafrost evaluation, and mapping. Special efforts will be devoted to marine surveys of Arctic Islands water crossings, including studies of the equipment required to construct such installations.

At present, Panarctic has about one-third of the required threshold gas reserve. Considering the drilling to be undertaken and assuming a continuation of present success ratios, the threshold gas reserves should be established by 1974. Other companies, encouraged by Panarctic's successes, are actively exploring in the Arctic Islands. It is reasonable to expect that successes by these companies will contribute to the threshold reserve.

Considering the foregoing, and making some allowance for inevitable delays, it is reasonable to anticipate the marketing of Arctic Islands natural gas by the end of this decade. Crude oil, if it is discovered in adequate quantity, could precede this date.

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